FORM PTO-1390(Modified) (REV 11-2000) U S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **DN1999219USA**

U S. APPLICATION NO (IF KNOWN, SEE 37 CFR): **10/089135**

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US99/22882	**October 1, 1999**	

TITLE OF INVENTION
APPARATUS FOR MONITORING A CONDITION OF A TIRE

APPLICANT(S) FOR DO/EO/US
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ESCHBACH, Elyse Kristen **STARKEY, Gene Raymond**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S C 371
3. ☐ This is an express request to begin national examination procedures (35 U S C 371(f)) The submission must include items (5), (6), (9) and (24) indicated below
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31)
5. ☒ A copy of the International Application as filed (35 U.S.C 371 (c) (2))
   a ☐ is attached hereto (required only if not communicated by the International Bureau)
   b. ☐ has been communicated by the International Bureau.
   c ☒ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☐ An English language translation of the International Application as filed (35 U S C 371(c)(2))
   a ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U S C 371 (c)(3))
   a ☐ are attached hereto (required only if not communicated by the International Bureau).
   b ☒ have been communicated by the International Bureau.
   c ☐ have not been made, however, the time limit for making such amendments has NOT expired.
   d ☐ have not been made and will not be made
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U S C 371(c)(3))
9. ☒ An oath or declaration of the inventor(s) (35 U S C 371 (c)(4))
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U S C 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409)
12. ☒ A copy of the International Search Report (PCT/ISA/210)

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1 98
14. ☐ An assignment document for recording A separate cover sheet in compliance with 37 CFR 3 28 and 3 31 is included.
15. ☒ A **FIRST** preliminary amendment
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U S.C 1 821 - 1 825
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U S C 154(d)(4)
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information

U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/089135	PCT/US99/22882	DN1999219USA

24. The following fees are submitted	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1 482) nor international search fee (37 CFR 1 445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO . **$890.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO **$740.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
☐ International preliminary examination fee (37 CFR 1 482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) . . **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e))	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	24 - 20 =	4	x $18.00	**$72.00**	
Independent claims	2 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$962.00**	
☐ Applicant claims small entity status See 37 CFR 1 27) The fees indicated above are reduced by 1/2				**$0.00**	
SUBTOTAL =				**$962.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)) +				**$0.00**	
TOTAL NATIONAL FEE =				**$962.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)) The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3.31) **(check if applicable).** ☐				**$0.00**	
TOTAL FEES ENCLOSED =				**$962.00**	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. **07-1725** in the amount of **$962.00** to cover the above fees A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No **07-1725** A duplicate copy of this sheet is enclosed

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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Howard M. Cohn
NAME

25,808
REGISTRATION NUMBER

March 25, 2002
DATE

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re	:	Application of Phelan et al.
For	:	**APPARATUS FOR MONITORING A CONDITION OF A TIRE**
Serial No.	:	
Filed	:	Concurrently herewith
Group Art Unit	:	
Examiner	:	
Our Docket No.	:	DN1999219USA

March 25, 2002

ASSISTANT COMMISSIONER
OF PATENTS
Box Patent Application
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

This is a preliminary amendment filed with a 35 U.S.C. 371 filing of a PCT International Application designating the United States.

Please amend the referenced application as follows:

IN THE CLAIMS

Please cancel claims 1-24 and replace with claims 25-48 as follows:

25. In conjunction with a pneumatic tire having a central tread, a radially-extending belt disposed radially inwardly of the tread and a radially-extending innerliner disposed radially inwardly of the belt, apparatus for mounting an electronic tag within the tire, characterized by:

a patch having a first side for mounting against the innerliner of the tire, a second arcuately-shaped side and an internally threaded member for threadably receiving an externally threaded member having a portion extending from a side of the electronic tag;

wherein:

when the electronic tag is attached to the patch, the electronic tag is external to the patch, and the side of the electronic tag abuts the arcuately-shaped side of the patch.

26. Apparatus, according to claim 25, characterized in that:

when the externally threaded member is threaded into the internally threaded member, a flat

side of the tag is in abutment with the arcuately-shaped side of the patch.

27. Apparatus, according to claim 25, characterized in that:

when the externally threaded member is threaded into the internally threaded member, a flat side of the tag is partially in abutment with the arcuately-shaped side of the patch.

28. Apparatus, according to claim 27, characterized in that:

when the externally threaded member is threaded into the internally threaded member, approximately one-half of a flat side of the tag is substantially in abutment with the arcuately-shaped side of the patch.

29. Apparatus, according to claim 25, characterized in that:

the internally threaded member includes a nut.

30. Apparatus, according to claim 25, characterized in that:

the patch is mounted to the innerliner adjacent a shoulder portion of the tire.

31. Apparatus, according to claim 25, characterized in that:

the patch is mounted to the innerliner at an area of the innerliner where the tire is thickest.

32. Apparatus, according to claim 25, characterized in that:

the patch is mounted to the innerliner at an area of the innerliner where the tire is least able to dissipate heat.

33. Apparatus, according to claim 25, characterized in that:

the patch is mounted to the innerliner at an area of the innerliner where the temperature samples are the most closely related to determining whether or not an internal breakdown of the tire is imminent.

34. Apparatus, according to claim 25, characterized in that:

the patch comprises vulcanized rubber.

35. Apparatus, according to claim 25, characterized in that:
the side of the tag from which the externally threaded member extends is flat.

36. Apparatus, according to claim 25, characterized in that:
the tag is substantially rectangularly-shaped and the side is substantially straight.

37. Apparatus, according to claim 25, characterized in that:
the internally threaded member includes a nut; and
the externally threaded member includes a bolt.

38. Apparatus, according to claim 25, characterized in that:
the electronic tag is adapted, in use, to:
sense a first temperature which is the temperature of the tire innerliner adjacent to the belt edge;
sense a second temperature which is the air temperature within the tire; and
sense air pressure within the tire.

39. Electronic tag for monitoring conditions of a pneumatic tire, the pneumatic tire comprising a central tread, a radially-extending belt disposed radially inwardly of the tread and a radially-extending innerliner disposed radially inwardly of the belt, the belt having a side edge, characterized by:
a first sensor for sensing a first temperature which is the temperature of the tire innerliner adjacent to the belt edge;
a second sensor for sensing a second temperature which is the air temperature within the tire; and
a third sensor for sensing air pressure within the tire.

40. Electronic tag, according to claim 39, characterized by:
a microcontroller for enabling sensing the conditions at a sequence of discrete time intervals.

41. Electronic tag, according to claim 40, characterized by:

the microcontroller compares a value of one or more of the conditions sensed at an immediately previous time interval to a current value of the one or more conditions.

42. Electronic tag, according to claim 40, characterized by:

at a current time interval, the microcontroller determines whether select one or more of the conditions has changed by a threshold amount since an immediately previous time interval.

43. Electronic tag, according to claim 42, characterized in that:

the select one or more conditions is either or both of the first and second temperatures; and

the threshold amount is plus or minus two degrees centigrade.

44. Electronic tag, according to claim 42, characterized in that:

the select one or more conditions is the air pressure within the tire; and

the threshold amount is plus or minus two pounds per square inch.

45. Electronic tag, according to claim 39, characterized in that:

the electronic tag is disposed adjacent a shoulder portion of the tire.

46. Electronic tag, according to claim 39, characterized by:

the electronic tag is disposed at an area of the innerliner where the tire is thickest.

47. Electronic tag, according to claim 39, characterized by:

the electronic tag is disposed at an area of the innerliner where the tire is least able to dissipate heat.

48. Electronic tag, according to claim 39, characterized by:

the electronic tag is disposed at an area of the innerliner where the temperature samples are the most closely related to determining whether or not an internal breakdown of the tire is imminent.

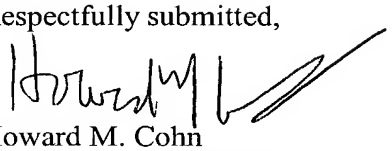
REMARKS

The claims have been amended to delete the numbers identifying elements, which were

originally incorporated to comply with PCT practice.

Favorable examination and consideration are respectfully requested.

Respectfully submitted,



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APPARATUS FOR MONITORING A CONDITION OF A TIRE

TECHNICAL FIELD

The present invention is generally concerned with a process and apparatus for monitoring a condition of a tire, and more particularly with a process and apparatus for monitoring a condition of a pneumatic tire for diagnosing an impending failure thereof.

BACKGROUND OF THE INVENTION

In order to transport bulk materials, such as coal, iron ore and other minerals, the mining industry uses Off-The-Road (OTR) vehicles that typically weigh up to 250 tons when fully loaded, with the result that exceedingly high internal stresses are imposed on the tires of such vehicles in the course of their daily use. Such internal stresses, which are primarily attributable to a number of factors including driving at excessive speeds, are so destructive of such tires that it is not uncommon to have to replace the tires. On the other hand, in order to maximize the productivity of OTR vehicles, they are normally driven as fast as possible until a user perceives that the internal physical condition of any given tire is marginal. Whereupon, the operator either stops, in the case of a loss of tire pressure, or reduces the speed of the vehicle, in the case of an excessive temperature condition, to relieve the internal stresses giving rise to the marginal condition, thereby prolonging the life of the tires. Thus the speed of an OTR vehicle is controlled on the basis of the operator's perception of the condition of the tires at any given time. And, if the operator's perception is erroneous, the productivity of the vehicle is unnecessarily reduced.

Accordingly, a long-standing need of the mining industry has been to ensure that the operators of OTR vehicles are provided with accurate information concerning various conditions of the tires of such vehicles, with a view to maximizing the productivity of the vehicles.

Various attempts have been made in the prior art to meet the aforesaid need, most recently by mounting integrated circuits within each of the tires of an OTR vehicle, for detecting respective conditions related to an imminent failure of

each tire and providing the OTR vehicle operators with timely information concerning such conditions.

For example, U.S. Patent No. 5,562,787, issued to Koch et al., disclosed a method and apparatus for monitoring respective conditions in the tires of vehicles. The apparatus comprises a monitoring device that is connectable to the interior of a tire and includes an integrated circuit having a transmitter. In addition, the monitoring device includes a plurality of sensors connected to the integrated circuit. The sensors continuously detect respective conditions of the tire and provide corresponding signals to the integrated circuit. The integrated circuit is programmed to periodically sample the tire condition signals, to compare the respective samples to respective standards, to generate respective tire condition signals based on the comparisons, and to provide an information signal to the operator of the vehicle when any tire condition signal is indicative of a marginal condition of the tire. In addition, the integrated circuit is programmed to be normally dormant but to transmit information signals concerning the then current tire condition signal to the operator in response to receiving a wake-up signal from the operator. Moreover, the integrated circuit may also be programmed to store data corresponding to periodic tire condition signals for historical, record keeping, purposes, and to cause the transmitter to transmit such historical data in response to receiving another wake-up signal.

As discussed in European Patent No. EP 0 936 089 A2, published August 18, 1999, in order to avoid the stress, strain, impact and cyclic fatigue that such monitoring devices are ordinarily exposed to when mounted within a tire, the prior art integrated circuits along with the attached transmitter and sensors have been encapsulated in rigid or semi-rigid materials, such as urethanes, epoxies, polystyrene resins, hard rubber compounds, or the like. The encapsulations have then been assembled with a battery connected thereto. The resulting assembly, know in the prior art as an electronic tire tag, has then been wrapped with a green rubber material forming a housing therefor, and the housing has thereafter been added to the structural green rubber material forming a tire assembly and been vulcanized therewith for forming a cured tire. The cured tire thus includes an

electronic tire tag embedded in the tire and forming a part thereof, and is discarded when the tire is discarded.

To provide for repair and replacement of such electronic tire tags, the aforesaid European Patent, which is assigned to the assignee of the aforesaid U.S. Patent, discloses a method and apparatus for removably mounting such tags within a tire. The apparatus includes a rubber patch, which may be vulcanized with the tire but is preferably separately vulcanized and attached to a vulcanized tire. The rubber patch includes a housing having a cavity formed therein. The cavity has a sidewall and is dimensioned for removably receiving therein the electronic tire tag. The electronic tag of the European Patent includes the above discussed structure of the U.S. Patent, including a transmitter, sensors and a battery, it being noted that the aforesaid U.S. Patent is incorporated by reference into, and made a part of, the European Patent. In addition, the European Patent calls for the optional inclusion of an antenna extending from the encapsulation. Assuming the provision of the antenna, opposed slots are formed in the sidewall of the housing for receiving the antenna when the tag is removably connected to the housing of the rubber patch. For retaining the tag in the housing, the housing and tag are respectively provided with compatible connecting means, such as the structures discussed in the European Patent, wherein the tag is either removably pinned, splined, threadably connected or interlocked to the housing.

Notwithstanding the aforesaid advancements of the prior art, the data provided to the operators of OTR vehicles, concerning the temperature conditions of the tires of such vehicles, continues to inaccurately reflect marginal conditions of the tires, due to various factors. For example, the practice of the prior art is to mount electronic tire tags centrally of the innerliner of a tire, in order to minimize the effects of stress, strain, impact vibration and cyclic fatigue imposed on the electronic tags. As a result, the monitoring devices sample tire temperatures at a location that is removed a considerable distance from the area of the tire where the temperature is most closely indicative of a marginal condition signaling an impending breakdown of the tire, that is, the temperature at the side edges of the belts, and thus near the shoulder portions of tires, where delaminations of the ply, belts and surrounding rubber materials occur due to the build up of internal

stresses. In order to compensate for the difference between the sensed temperature and the temperature at such side edges, the prior art integrated circuits have algorithms that apply a scaling constant to the sensed temperature to calculate the temperature from the center of the innerliner to the vicinity of the shoulder portions of the tire. Unfortunately, the tire temperature at the center of the innerliner of a given tire may be significantly less than the temperature at shoulder portions of the tire, and change with different tire designs.

Accordingly, in addition to the problem of tag location, it has been found that the prior art algorithms inaccurately calculate the temperatures at the side edges of the belt, due to such calculations being based on adding a constant temperature factor to the temperature measured at the centerline of the tire to compensate for the distance that the temperature sampling sensor is spaced from the side edges of a belt. Since the location of the temperature sensors and such calculations result in providing erroneous information to the operators of OTR vehicles, the operators may prematurely reduce the speed of such vehicles. The consequent adverse effect on the productivity of such vehicles is costly to the mining industry.

SUMMARY OF THE INVENTION

According to the invention, there is in conjunction with a pneumatic tire having a central tread, one or more radially-extending belt(s) disposed radially inwardly of the tread and an innerliner disposed radially inwardly of the belt, apparatus for mounting an electronic tag within the tire, characterized by a patch having a first side for mounting against the innerliner of the tire, a second arcuately-shaped side and an internally threaded member; and an externally threaded member having a portion extending from a side of the tag and threadable into the internally threaded member of the patch. The side of the tag from which the externally threaded member extends is flat. When the externally threaded member is threaded into the internally threaded member, the flat side of the tag is in abutment with the arcuate side of the patch. Also, when the externally threaded member is threaded into the internally threaded member, the flat side of the tag is partially in abutment with the arcuate side of the patch, approximately one-half of the flat side of the tag is substantially in abutment with the arcuate side of the patch. The tag is substantially rectangularly-shaped

and the side is substantially straight. The internally threaded member includes a nut; and the externally threaded member includes a bolt.

The electronic tag is adapted, in use, to sense a first temperature which is the temperature of the tire innerliner adjacent to the belt edge; sense a second temperature which is the air temperature within the tire; and sense air pressure within the tire.

BRIEF DESCRIPTION OF THE DRAWINGS

As shown in the drawings, wherein like reference numerals designate like or corresponding parts throughout the several views:

Figure 1 is a partial, one-half, cross-sectional view of a pneumatic tire having mounted therein an electronic tire tag according to the invention;

Figure 2 is an enlarged transverse cross-sectional view of the general details of the tag of Figure 1, showing the encapsulating and mounting structures thereof;

Figure 3 is a block diagram of a portion of an electronic control system according to the invention;

Figure 4 is a block diagram of another portion of the electronic control system shown in Figure 3;

Figure 5 is a flow chart portraying a portion of a process according the invention; and

Figures 6A and 6B comprise a flow chart portraying another portion of the process shown in Figure 4.

DEFINITIONS

"Bead" generally means an annularly shaped, member located within either of the inner radial end portions of a tire;

"Bead Portion" generally means either of the opposed radial inner end portions of the carcass of a tire including a bead, the portion of a ply which is looped about the bead, and the rubber material surrounding the bead and ply portion.

"Carcass" generally means the tire structure including the beads and ply, but excluding the belt structure, undertread over the ply and the tread.

"Equatorial Plane" means the imaginary plane extending perpendicular to the axis of rotation of the tire and passing through the center of the tread; or the plane containing the circumferential centerline of the tread.

"Ply" generally means a cord-reinforced layer of rubber-coated, radially deployed material.

"Radial" mean directions extending radially toward or away from the axis of rotation of the tire.

"Sidewall" generally means the radially-extending portion of a tire.

"Tread width," means the arc length of the outer circumference of the tread of a tire as viewed in transverse cross-section.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows half of a partial transverse cross-sectional view of a typical pneumatic tire 10, for an OTR vehicle 11, mounted on a wheel rim 12 thereof. Since the tire 10 is generally toroidally-shaped and symmetrically arranged with respect to an imaginary equatorial plane 14, the transverse cross-section of the other partial half of the tire 10 includes like or corresponding parts, and it should be understood that the explanation applies to the other half of the tire 10 as well.

The tire 10 which has a cavity 16 for receiving pressurized air when the tire 10 is mounted on the wheel rim 12, generally comprises a central tread 16 having opposite sides generally indicated by the numeral 18. In addition, the tire 10 includes a plurality of radially-extending belts, exemplified by the belts 20 and 22, that are centrally disposed radially-inwardly of the tread 16. The belt 20 has opposite side edges 23, and the belt 22 has opposite side edges 24. Further, the tire 10 includes a carcass 25 having opposite sidewalls 27. The respective sidewalls 27 merge with and radially-extend inwardly from opposite tread sides 18 and form therewith opposite shoulder portions generally indicated by the numeral 28. The carcass 25 also includes opposite bead portions 29 at the radial inner ends thereof. Each of the bead portions 29 includes an annularly-shaped bead 29A therein for urging the bead portions 29 into abutment with the wheel rim 12. Moreover, the carcass 25 includes one or more plies 30, radially disposed inwardly of the belts 20 and 22. The ply 30 radially extends between and is

looped about the opposed beads 29A. And, the carcass 25 includes a radially extending innerliner 35 disposed radially inwardly of the ply 30.

According to the invention, an electronic tire tag 40 (Figures 1 and 2) is preferably fixedly secured to the innerliner 35 of the tire 10 at an area thereof which is located substantially directly radially-inwardly of a side edge 23 of the belt 20 that is closest to the innerliner 35 of the tire 10 and thus adjacent to a shoulder portion 28 of the tire 10. Since the tag 40 is thereby located adjacent at the an area of the innerliner 35 where the tire 10 is thickest and least able to dissipate heat, the temperature measurements taken at this location are the most closely related to determining whether or not an internal breakdown of the tire 10 is imminent. The breakdown is typically due to internal stresses causing delaminations of the belts 20 and 22, ply 33 and surrounding vulcanized rubber material 36 at the shoulder portions 28 of the tire 10. Figure 1 also shows the relative dimensions of the width "w1" of the tire tread 16 of a typical OTR vehicle 11, that is, substantially 3 to 4 feet, and the width "w2" of the tag 40 connected thereto, that is, substantially 3 inches.

The electronic tag 40 (Figures 1 and 2) generally comprises a micro-controller 42 and first temperature sensing structure 44 electrically connected thereto for sampling the temperature of the innerliner 35 of the tire 10. In addition, the tag 40 includes second temperature sensing structure 46 electrically connected to the micro-controller 42 for sampling the air temperature within the tire 10. Further, the tag 40 generally includes pressure sensing structure 48 electrically connected to the micro-controller 42 for sampling the air pressure within the tire 10. Moreover, the tag 40 includes transmitter structure 50 electrically connected to the micro-controller 42 for transmitting relevant information concerning the respective samplings taken by the temperature and pressure sensing structures 44, 46 and 48. Still further, the tag 40 preferably includes a battery 51 that is conventionally electrically connected to the micro-controller 42 for energization thereof. The pressure sensing structure 48 includes a tubular portion 52 thereof extending from the tag 40. In addition, the transmitter structure 50 preferably includes an antenna 58. The tag 40 also includes structure 60 for connecting the tag 40 to the tire 10. The connecting structure 60 preferably

includes a first internally threaded nut 62, and an externally threaded bolt 64. The bolt 64 is permanently threadably connected to the first nut 62 and has a threaded portion 64 thereof extending from the tag 40. The tag 40 is preferably entirely encapsulated in a encapsulation material 65 such as a mixture of epoxy and glass beads coated with urethane.

The encapsulated tag 40 (Figure 2) is preferably not directly connected to the innerliner 35 of the tire 10. Rather, according to the invention, a vulcanized rubber patch 70, having embedded therein a second internally threaded nut 71, is affixed to the innerliner 35 of the tire 10. Preferably, the patch 70, has a lens-shaped transverse cross-section, defined by a substantially flat side 72 having a generally circular perimeter being connectable to the innerliner 35 of the tire 10 and an arcuately-shaped inner side 73 disposed on the opposite side of the patch. Side 72 of the patch 70 is dimensioned for disposition in abutment with the substantially arcuately shaped area of the innerliner 35 of the tire 10 at the shoulder portion 28 thereof. Side 73 of the patch 70 faces the interior of the tire 10. The encapsulated tag 40 has a substantially rectangularly-shaped transverse cross-section and includes a substantially straight side 74. The encapsulated tag 40 is connected to the patch 70 by threadably connecting the bolt portion 64A, extending from the tag 40, to the second nut 71. Due to the arcuate shaped transverse surface 73 of the patch 70, the side surface 74 of the attached tag 40 is separated from the patch 70 along substantially one-half of the arcuately shaped surface 73 of the patch 70. A generally circular central portion 73A of the surface 73 is substantially in abutment with surface 74 when the bolt portion 64A of the tag 40 is threadably connected to the nut 71 of the patch 70. Concurrently, the bolt portion 60 (Figure 1) of the connected tag 40 is located substantially in abutment with an area of the innerliner 35 adjacent to a belt edges 21 at the shoulder portion 28 of the tire 10 for sensing the temperature thereat. While the connected tag 40 is preferably located at the shoulder portion 28 adjacent to the ends of the one or more belts 20,22, it is also within the terms of the invention to locate the tag 40 near or on the center line 14 of the tire 10.

Preferably, the first temperature sensing structure 44 (Figure 2) is then conventionally thermally connected through the interconnection substrate 4, such

as a printed circuit board (PCB), to bolt 64 for sensing the temperature thereof and thus the temperature at the innerliner 35 where the patch 70 is attached.

The aforesaid arcuate transverse cross-section of the patch 70 (Figure 2) is believed to prevent the patch 70 and attached tag 40, or the tag 40 and attached nut 71, from separating from the tire 10 in the course of rotation thereof. In this connection it is noted that as the tire tread 16 (Figure 1) adjacent to the area of the innerliner 35 where the patch 70 and tag 40 tag are connected thereto rolls into contact with the ground, the tread 16, and thus the innerliner 35 and the radially outwardly extending side 72 of the attached patch 70, flatten. Thereafter, as the tire tread 16 (Figure 1) adjacent to the area of the innerliner 35 where the patch 70 and tag 40 are connected thereto rolls out of contact with the ground, the tread 16 and thus the innerliner 35 and the radially outwardly extending side 72 of the attached patch, abruptly assume the arcuately-shape form thereof show in Figure 1. As a result of the abrupt conformation of the innerliner 35 and the radially outwardly extending substantially flat side 72 of the patch conforming to the arcuately-shaped form thereof shown in Figure 1, the flexure stress imposed on the patch 70 and attached tag 40 may cause patch 70 and attached tag 40, or the tag 40 and attached nut 71, to eventually separate from the innerliner 35 of the tire 10 in the course of rotation thereof. It has been determined that when the inwardly extending side 73 of the patch 70 is arcuately shaped as shown in Figure 2, the patch 70 is able to flex without imposing significant flexure stresses on the attached tag 40.

As shown in greater detail in Figure 3, the micro-controller 42 includes a first conventional microprocessor 80, having ports p1 through p28 inclusive. The first microprocessor 80 internally includes a conventional analog to digital (A/D) converter 82. In addition, the first microprocessor 80 internally includes a conventional multiplexer 82A that is conventionally electrically connected to a plurality of the ports, p2-p5 and p7, of the microprocessor 80. Moreover, the microprocessor 80 internally includes a conventional clock circuit 83 connected to ports p9 and p10 thereof.

Further, the transmitter structure 50 (Figure 3) includes a second conventional microprocessor 84 having an internal counting circuit 85, that is

conventionally electrically connected to the first microprocessor 80, at port p11 thereof, for receiving and sending respective reset signals "Rs" and data signals "Ds" via respective data and reset leads "Ld" and "Lr". Preferably, the first and second temperature sensing structures 44 and 46 (Figure 4), are directly electrically connected to the first microprocessor 80, at ports p2 and p3 thereof, for providing respective first and second temperature sampling signals " Ts1" and "Ts2" thereto. Optionally, the micro-controller 42 may include first and second operational amplifiers, 90 and 92, respectively connected between the first and second temperature sensing structures 44, 46, and the first microprocessor 80 for providing amplified temperature sampling signals, Ts1 and Ts2, thereto. In addition, the micro-controller 42 preferably includes an instrumentation amplifier 95, conventionally electrically connected between the pressure sensing structure 48 and the first microprocessor 80, at port 7. Furthermore, the micro-controller 42 preferably includes conventional reference voltage generating structure 96 that is preferably directly connected to the pressure sensing structure 48, for providing respective reference voltage signals "Vref" thereto. The reference voltage generating structure 96 is preferably additionally conventionally connected to the first microprocessor 80, at port p5 thereof, for providing thereto a reference voltage sample signal "Vref". Optionally, the micro-controller 42 may also include of a third operational amplifier 98, conventionally electrically connected between the reference voltage generating structure 96 and the pressure sensing structure 48 for providing an amplified reference voltage signal Vref thereto. The pressure sensing structure 48 (Figure 1) samples the air pressure of the tire 10 via the tubular portion 52 (Figure 2 thereof extending into the tire cavity 16, and provides first and second analog pressure signals "Ps1" and "Ps2 " (Figures 4 and 5) corresponding thereto to the instrumentation amplifier 95. And, the instrumentation amplifier 95 generates and provides to the first microprocessor 80, at port p7 thereof, an analog pressure difference sample signal "Pds" corresponding to the difference between the pressure signals Ps1 and Ps2. The pressure difference sample Pds is generally at a maximum when the sensed pressure is at its full scale limit, and is at a minimum when the tire 10 is fully deflated.

The micro-controller 42 (Figure 3) additionally includes a conventional oscillator 100 having clock input and clock output leads, "Cin" and "Cout, respectively electrically connected to the first microprocessor 80 at ports p9 and p10 thereof and thus to the clock circuit 83 thereof.

Moreover, the micro-controller 42 (Figure 3) preferably includes conventional watchdog timing structure 105 that is conventionally electrically connected across the data and reset leads, Ld and Lr, of the transmitting structure 50 and to port p13 of the first microprocessor 80. The watchdog timing structure 105 includes a third conventional microprocessor 106 having a conventional, internal, low frequency counting oscillator 107. Moreover, the watchdog timing structure 105 includes higher frequency oscillator 108 externally of the third microprocessor 106. The internal counting oscillator 107 continuously counts successive seconds for a predetermined time interval, provides a count signal Cs to the reset-signal generating oscillator 108 upon counting for the predetermined time interval, and then recycles to commence a new count. If the watchdog timing structure 105 does not detect a voltage signal Vs1 at port p13 of the first microprocessor 80 and a transmitter data signal Ds, then, upon receiving the count signal Cs, the reset signal generating oscillator 108 provides a wake-up resetting signal "Wup" to both the transmitter microprocessor 84, on the reset lead Lr, and the first microprocessor 80 via a conventional high impedance pull-up resistor 110 connected to port p1 of the first microprocessor 80.

The micro-controller 42 also includes a single pole, double throw, electronic switch 112. The switch 112 preferably includes a input signal lead "Lin" electrically connected to the first microprocessor 80, at port 15 thereof, for receiving input signals therefrom. In addition, the switch 112 has a common lead "Lc" electrically connected to the data lead Ld extending between the transmitting structure 50 and the first microprocessor 80, at port 11 thereof. Furthermore, the switch 112 includes normally closed and normally open switch leads, "Lnc" and "Lno", respectively electrically connected to the first microprocessor 80 at ports p17 and p18 thereof. When the switch 112 is in the normally open position thereof, data from port p18 of the first microprocessor 80, is applied to the data lead Ld of the transmitter structure 50 for use thereby. When the switch 112 is in

the normally closed position thereof, data on the data lead Ld of the transmitter structure 50 is applied to port p17 of the microprocessor 80 for use thereby. The switch 112 is usually in the normally open position thereof, for providing temperature, pressure, reference voltage level and transmitter voltage level data 114 to the transmitter structure 50. After having provided such data 114, the first microprocessor 80 applies a signal 116 from port p15 to the switch 112, resulting in the switch 112 being switched to the normally closed position. Whereupon the transmitter structure 50 provides an acknowledgement signal 118 to the first microprocessor 80 and returns the data 122 thereto. In the event that such data 122 is returned without an acknowledgement signal 118, the first microprocessor 80 causes the switch 112 to be returned to the normally open position thereof and repeats the provision of the data 122, and so on, until either an acknowledgement signal 124 is provided to the first microprocessor 80 or the data has been applied to the data lead Ld at least two times.

The battery 51 is conventionally electrically connected to the first microprocessor 80 by means of a first RC circuit 124, having a first conventional storage capacitor 126 for providing a first stabilized input voltage "Vs1" at port p20 of the first microprocessor 80, at the switch 112 and at the watchdog timing structure 105, for respective energization thereof. Moreover, the battery 51 is conventionally electrically connected to the transmitting structure 50 by means of a second RC circuit 128, having a second conventional storage capacitor 130 for providing a second stabilized input voltage "Vs2" to the transmitter structure 50. The micro-controller 42 (Figures 3 and 4) also preferably includes transmitter voltage sensing structure 136 that is conventionally electrically connected between the second storage capacitor 130 and at port p4 of the first microprocessor 80, for sensing the transmitter-structure input voltage Vs2 and providing an input voltage sample signal "Vs2s" to port p5 of first microprocessor 80. The transmitter input voltage sensing structure 136 preferably includes a high impedance voltage dividing circuit 138 having a first high impedance resistor 140 connected in series with the first microprocessor 80 and a second high impedance resistor 142 connected across the first microprocessor 80 to ground "G1". Optionally, the transmitter input voltage sensing structure 136 may include a fourth operational

amplifier 141 that is conventionally electrically connected between the first resistor 140 of the voltage dividing circuit 138 and the first microprocessor 80 for providing an amplified transmitter voltage input sample signal Vs2s to the first microprocessor 80. The first microprocessor 80 additionally includes a voltage output lead "Vs1" extending to the sensing structures 44, 46, the reference voltage generating structure 96 and the instrumentation amplifier 95, respectively for operation thereof. Moreover, assuming the provision of any of the first, second third or fourth operational amplifiers, 90, 92, 98, or 140, the voltage output lead Vs1 would also extend thereto for operation thereof.

It is noted that the first, second and third microprocessors 80, 84, and 106, respectively, are conventionally programmed to execute each of the steps, if any, attributed thereto in the foregoing discussion and in following process. When the tag 40 (Figure1) is installed in a tire 10 that is inflated and mounted on the wheel rim 12 of a vehicle 11, exemplified by an OTR vehicle, the process portrayed in Figures 5 and 6 is started (step 200). Thereafter, the first microprocessor 80 and transmitter structure 50, and thus the second microprocessor 84 thereof, are concurrently energized (steps 202 and 204). The second microprocessor 84 of the transmitter structure 50 then generates a pulse 210 (step 206) at the end of a predetermined time interval, exemplified by the time interval of 1.4 seconds. The pulse 206 is applied by the second microprocessor 84 to the internal pulse counter 85 (step 208) followed by the second microprocessor 84 implementing the step 212 of inquiring whether a predetermined pulse count, exemplified by a pulse count of 152 pulses, has been attained. Assuming, the inquiry is answered negatively (step 210), processing is returned to step 206 and recycled therethrough and through steps 210, and 212 until the inquiry of step 212 is answered affirmatively. Without departing from the spirit and scope of the invention, the pulse counter 85 may be conventionally loaded with a predetermined count, exemplified by the count of 152 pulses, and be programmed to sequentially count down to zero in response to the application thereto of sequential pulses 210. In either case, when the inquiry of step 212 is answered affirmatively, the second microprocessor 84 causes the pulse counter 83 to be reset (step 214), return processing to step 206 to

recommence the aforesaid pulse generation and counting process, and provide another count signal 216 to the first microprocessor 80.

Upon detecting the count signal 216 (Figure 5), the first microprocessor 80 applies the voltage Vs1 to the first and second temperature sensing structures 44 and 46, the reference voltage generating structure 96, the transmitter voltage sensing structure 136 and the pressure sensing structure 48 (steps 220, 222, 224, 226 and 228, respectively) for energization thereof. As a result, the first and second temperature sensing structures 44 and 46, respectively, provide first and second temperature samples Ts1 and Ts2 (steps 230 and 232) to the first microprocessor 80, which are representative of the respective temperatures of the tire innerliner 35 and the tire cavity 16. In addition, the reference voltage generating structure 96 provides a reference voltage sample Vrefs to the first microprocessor 80 (step 234) that is representative of the reference voltage Vref. In addition, the transmitter voltage sensing structure 136 provides a transmitter voltage sample Vs2s to the first microprocessor 80 (step 236) that is representative of the transmitter voltage Vs2. And the tire pressure instrumentation amplifier provides a pressure difference sample Pds to the first microprocessor 80 (step 238) that is representative of the air pressure Ps1 of the tire 10.

The multiplexer 82A of the first microprocessor 80 conventionally sequentially scans ports p2-p5 and p7 thereof and sequentially applies the temperature and pressure signals to the A/D converter thereof. The A/D converter 82 sequentially converts the respective first and second temperature samples, Ts1s and Ts2s (steps 242 and 244) to respective digital temperature signals Vt1s and Vt2s, each having a voltage level of 10 millivolts per degree C (centigrade), and converts the pressure difference sample Pds (step 246) to a digital pressure difference signal Vpds having a voltage level of the 16 millivolts per pound per square inch. The first microprocessor 80 then sequentially inquires (steps 250 and 252), whether the respective digital temperature sample signals Vt1s and Vt2s are greater than a predetermined voltage level corresponding to a high temperature, exemplified by the temperature of 95 degrees C, and whether the digital pressure difference sample signal Vpds is less than a predetermined voltage level corresponding to low pressure, exemplified by the pressure of 80 pounds per

square inch, or greater than a predetermined voltage level corresponding to high pressure, exemplified by the pressure of 120 pounds per square inch. Assuming each of the inquiries of steps 250 and 252 are negatively answered, the first microprocessor 80 inquires, steps 254 and 256, whether the respective digital temperature sample signals, Vt1s and Vt2s, have changed by a predetermined voltage amount corresponding to a selected temperature change, exemplified by the temperature change of plus or minus 2 degrees C, since the last temperature sample was taken, and whether the digital pressure difference sample signal Vpds has changed a predetermined voltage amount corresponding to a selected pressure change, exemplified by the pressure change of plus or minus 2 pounds per square inch, since the last pressure difference sample was taken. Assuming each of 254 and 256 are answered negatively, then processing is returned to step 202.

On the other hand, if any of the inquires of steps 250, 252, 254 or 256 (Figure 6) is affirmatively answered, an unfavorable temperature sample, Vts1 or Tts2, or an unfavorable pressure difference sample signal Vpds or both, has been taken. Whereupon, the first microprocessor 80 applies both of the temperature sample signals, Vt1s and Vt2s, to the data lead Ld of the transmitter microprocessor 84 (step 260), if either of such temperature samples signals, Vt1s or Vt2s, is unfavorable, or applies the pressure difference sample signal Vpds to the data lead Ld of the transmitter microprocessor 84 (step 260), if the pressure difference sample Vpds is unfavorable, or applies both of the temperature sample signals, Vt1s and Vt2s, and the pressure difference sample signal Vpds to the data lead of the transmitter microprocessor 84 (step 260), if either of the temperature sample signal, Vs1s or Vs2s and the pressure difference sample signal Vpds are unfavorable. In addition, if any of the temperature or pressure difference sampling signals, Vts1, Vts2 or Vpds, is unfavorable, the first microprocessor 80 generates and applies an alarm signal "Alm" to the data lead Ld of the transmitter microprocessor 84 (step 260). Upon receiving the aforesaid alarm and sample signals, Alm, Vts1 and Vts2 and/or Vpds, the transmitter structure 84 preferably the transmits (step 262), such signals, Alm, Vts1 and Vts2 and/or Vpds, a plurality of times, for example 12 times, to a remote receiver 150 followed by the step 263 of providing a transmission acknowledgement signal ACK to step 202 of the first

microprocessor 80 and thereby returning processing thereto. The procedure of providing for multiple signal transmissions has been adopted to be sure that the transmitted signals, Alm, Vts1 and Vts2 and/or Vpds, are received by the remote receiver 150, which may be scanning for other input signals, outside of the scope of the present invention, at the time of the original transmission by the transmitter structure 50.

In addition to providing the signals Alm, Vts1 and Vts2 and/or Vpds (step 260) to the transmitter structure 50, the first microprocessor 80 inquires (step 264) whether the aforesaid acknowledgement signal ACK has been received. Assuming that the inquiry of step 264 is negatively answered, then, step 260 is repeated, step 266, followed by the first microprocessor 80 again inquiring (step 268) whether the aforesaid acknowledgement signal has been received. Assuming that step 268 is negatively answered, then, step 260 is again repeated (step 270), followed by returning processing to the first microprocessor (step 202). Assuming that either of steps 264 or 266 is affirmatively answered, processing is also returned to step 202.

As shown in Figure 3 and in step 240 (Figure 5), the multiplexer 82A of the first microprocessor 80 also sequentially scans ports p4 and p5 for the transmitter input voltage sample signal Vs2s and reference voltage sample signal Vrefs. Upon detecting such signals Vs2s, the microprocessor 80 sequentially inquires whether the transmitter input voltage sample signal Vs2s is low (step 290). Assuming the answer to the inquiry of step 290 is negative, then processing is returned to step 202, and, assuming the inquiry of step 292 is negative, processing is also returned to step 202. Assuming however that the answer to either or both of the inquiries of steps 290 and 292 is or are negative, indicating that either or both of the sample signals Vs2s is unfavorable, then, the first microprocessor 80 (step 294) generates and applies an alarm signal Alm, for each unfavorable sample signal Vs2s or Vrefs, to the data lead Ld of the second microprocessor 84 of the transmitter structure 50. Upon receiving the aforesaid alarm and sample signals Alm, Vs2s or Vrefs, or both, the transmitter structure 84 (step 296) preferably transmits such signals Alm and Vs2s, a plurality of times, for example 12 times for the reason hereinbefore discussed, to the remote receiver 150

followed by the step 298 of providing a transmission acknowledgement signal ACK to the first microprocessor 80 (step 202) thereby returning processing thereto.

In addition, to providing the signals Alm, and Vs2s or both to the transmitter structure 50, the first microprocessor 80 inquires (step 300), whether the aforesaid acknowledgement signal ACK has been received. Assuming that the inquiry of step 300 is negatively answered, then, step 296 is repeated (step 302), followed by the first microprocessor 80 again inquiring (step 304) whether the aforesaid acknowledgement signal ACK has been received. Assuming that step 304 is also negatively answered, then, step 296 is again repeated (step 306), followed by returning processing to the first microprocessor 80 (step 202). Assuming that either or both of steps 302 or 306 is affirmatively answered, then processing is also returned to step 202 of the first microprocessor 80.

The tag 40 (Figure 1) according to the invention can be incorporated in a monitoring system 149 including the remote computer 150 (Figure 6) and a display 160 which conventionally electrically connected the remote computer 150. The remote receiver 150 can include a conventional microprocessor 152 that is conventionally programmed to calculate the sum of the respective temperature sample signals Vt1s and Vt2 and divide the sum by the numeral 2, to generate an average temperature sample signal Vtsavg. In addition, remote computer microprocessor 152 is conventionally programmed to cause the display 160 to display the respective alarm and sample signals Alm,Tt1s, Tt2s, Vs2s, Vrefs, and Vpds received from the transmitter structure 50 and to display the temperature sample signal average Vtsavg generated by the remote microprocessor 152.

Although the inventions described herein have been shown in a few embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing teachings. Accordingly, the invention is intended to embrace all such alternatives, modifications and variations as fall within the spirit and scope of the appended claims.

What is claimed is:

1. In conjunction with a pneumatic tire (10) having a central tread (16), a radially-extending belt (20) disposed radially inwardly of the tread (16) and a radially-extending innerliner (35) disposed radially inwardly of the belt (16), apparatus for mounting an electronic tag (40) within the tire, characterized by:

a patch (70) having a first side (72) for mounting against the innerliner of the tire, a second arcuately-shaped side (73) and an internally threaded member (71) for threadably receiving an externally threaded member (64) having a portion extending from a side (74) of the electronic tag (40);

wherein:

when the electronic tag (40) is attached to the patch (70), the electronic tag (40) is external to the patch (70), and the side (74) of the electronic tag (40) abuts the arcuately-shaped side (73) of the patch (70).

2. Apparatus, according to claim 1, characterized in that:

when the externally threaded member is threaded into the internally threaded member, a flat side (74) of the tag is in abutment with the arcuately-shaped side of the patch.

3. Apparatus, according to claim 1, characterized in that:

when the externally threaded member is threaded into the internally threaded member, a flat side (74) of the tag is partially in abutment with the arcuately-shaped side of the patch.

4. Apparatus, according to claim 3, characterized in that:

when the externally threaded member is threaded into the internally threaded member, approximately one-half of a flat side (74) of the tag is substantially in abutment with the arcuately-shaped side of the patch.

5. Apparatus, according to claim 1, characterized in that:

the internally threaded member includes a nut (71).

6. Apparatus, according to claim 1, characterized in that:

the patch is mounted to the innerliner adjacent a shoulder portion (28) of the tire.

7. Apparatus, according to claim 1, characterized in that:

the patch is mounted to the innerliner at an area of the innerliner where the tire is thickest.

8. Apparatus, according to claim 1, characterized in that:

the patch is mounted to the innerliner at an area of the innerliner where the tire is least able to dissipate heat.

9. Apparatus, according to claim 1, characterized in that:

the patch is mounted to the innerliner at an area of the innerliner where the temperature samples are the most closely related to determining whether or not an internal breakdown of the tire is imminent.

10. Apparatus, according to claim 1, characterized in that:

the patch comprises vulcanized rubber.

11. Apparatus, according to claim 1, characterized in that:

the side of the tag from which the externally threaded member extends is flat.

12. Apparatus, according to claim 1, characterized in that:

the tag is substantially rectangularly-shaped and the side is substantially straight.

13. Apparatus, according to claim 1, characterized in that:

the internally threaded member includes a nut (71); and

the externally threaded member includes a bolt (64).

14. Apparatus, according to claim 1, characterized in that:

the electronic tag is adapted, in use, to:

sense (44) a first temperature which is the temperature of the tire innerliner adjacent to the belt edge;

sense (46) a second temperature which is the air temperature within the tire; and

sense (48) air pressure within the tire.

15. Electronic tag (40) for monitoring conditions of a pneumatic tire (10), the pneumatic tire comprising a central tread (16), a radially-extending belt (20) disposed radially inwardly of the tread (16) and a radially-extending innerliner (35) disposed radially inwardly of the belt (16), the belt (20) having a side edge (23), characterized by:

a first sensor (44) for sensing a first temperature which is the temperature of the tire innerliner adjacent to the belt edge;

a second sensor (46) for sensing a second temperature which is the air temperature within the tire; and

a third sensor (48) for sensing air pressure within the tire.

16. Electronic tag, according to claim 15, characterized by:

a microcontroller (42) for enabling sensing the conditions at a sequence of discrete time intervals.

17. Electronic tag, according to claim 16, characterized by:

the microcontroller compares a value of one or more of the conditions sensed at an immediately previous time interval to a current value of the one or more conditions.

18. Electronic tag, according to claim 16, characterized by:

at a current time interval, the microcontroller determines whether select one or more of the conditions has changed by a threshold amount since an immediately previous time interval.

19. Electronic tag, according to claim 18, characterized in that:

the select one or more conditions is either or both of the first and second temperatures; and

the threshold amount is plus or minus two degrees centigrade.

20. Electronic tag, according to claim 18, characterized in that:

the select one or more conditions is the air pressure within the tire; and

the threshold amount is plus or minus two pounds per square inch.

21. Electronic tag, according to claim 15, characterized in that:

the electronic tag is disposed adjacent a shoulder portion (28) of the tire.

22. Electronic tag, according to claim 15, characterized by:

the electronic tag is disposed at an area of the innerliner where the tire is thickest.

23. Electronic tag, according to claim 15, characterized by:

the electronic tag is disposed at an area of the innerliner where the tire is least able to dissipate heat.

24. Electronic tag, according to claim 15, characterized by:

the electronic tag is disposed at an area of the innerliner where the temperature samples are the most closely related to determining whether or not an internal breakdown of the tire is imminent.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 April 2001 (12.04.2001)

PCT

(10) International Publication Number
WO 01/25033 A1

(51) International Patent Classification[7]: B60C 23/04

(21) International Application Number: PCT/US99/22882

(22) International Filing Date: 1 October 1999 (01.10.1999)

(25) Filing Language: English

(26) Publication Language: English

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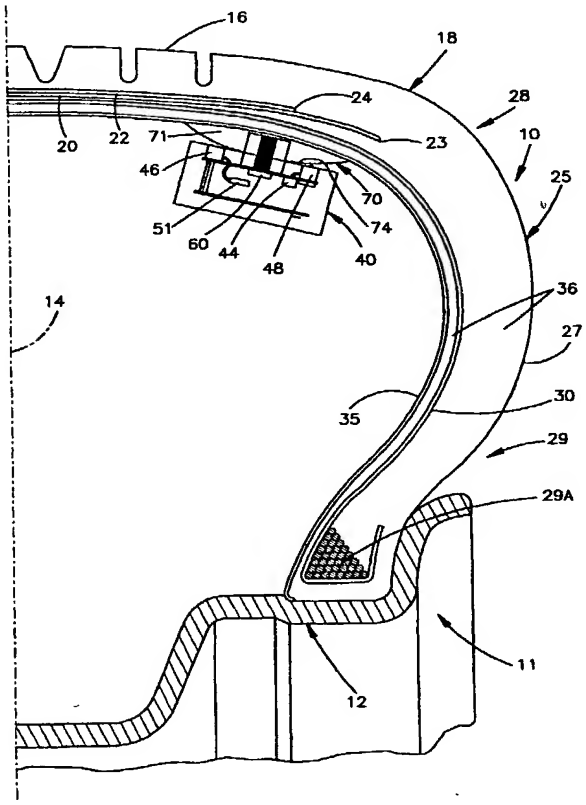
(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU,

[Continued on next page]

(54) Title: APPARATUS FOR MONITORING A CONDITION OF A TIRE



(57) Abstract: According to the invention there is in conjunction with a pneumatic tire having a central tread, one or more radially-extending belt(s) disposed radially inwardly of the tread and an innerliner disposed radially inwardly of the belt. Apparatus for mounting an electronic tag (40) within the tire is characterized by a patch (70) having a first side (72) for mounting against the innerliner of the tire; a second arcuately-shaped side (73) and an internally threaded member (71); and an externally threaded member (64) having a portion extending from a side (74) of the tag and threadable into the internally threaded member of the patch.

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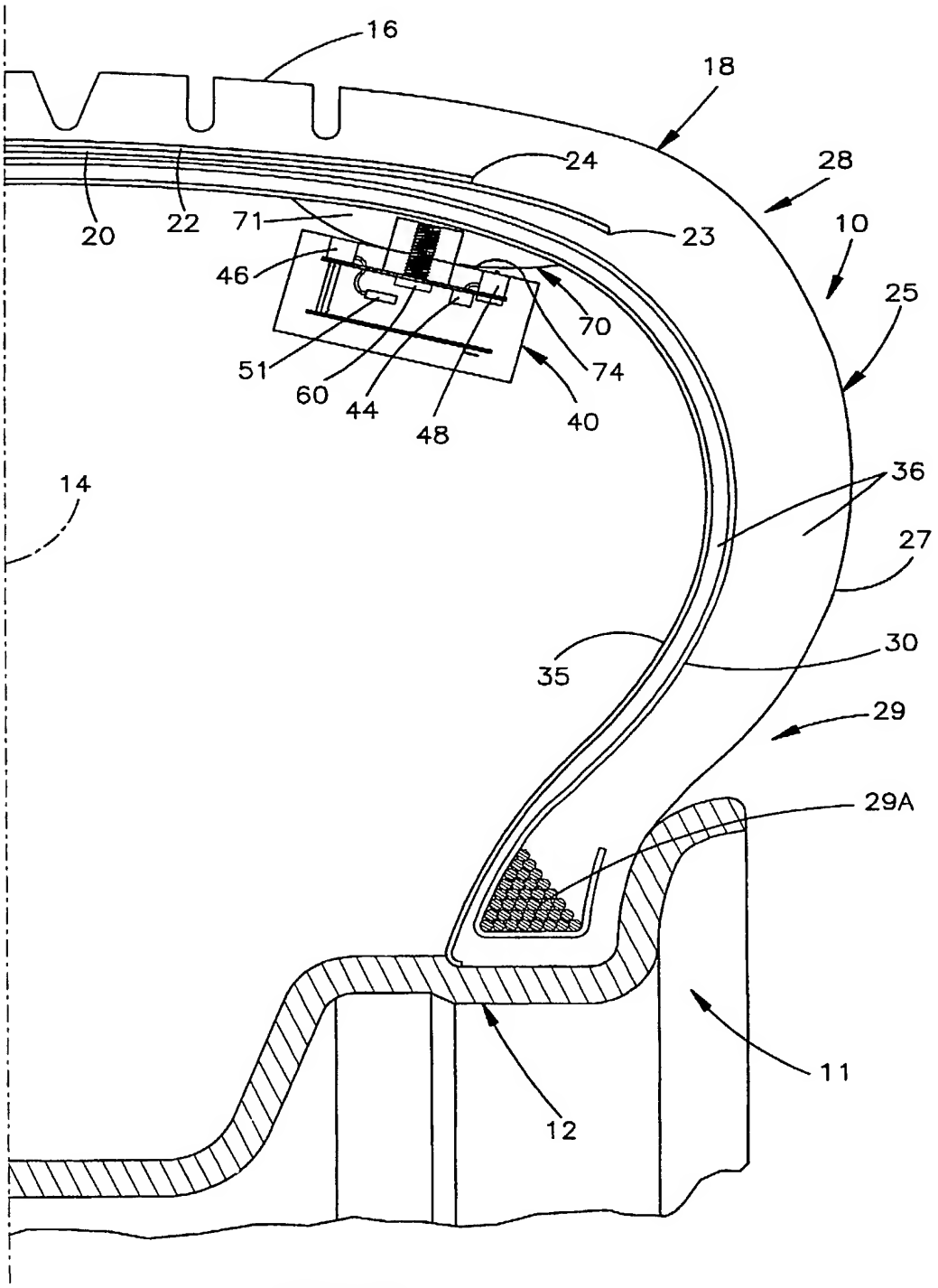
16
18
24
28
20
22
71
23
10
46
25
70
74
51
60
44
48
40
14
36
27
35
30
29
29A
11
12

Figure 1

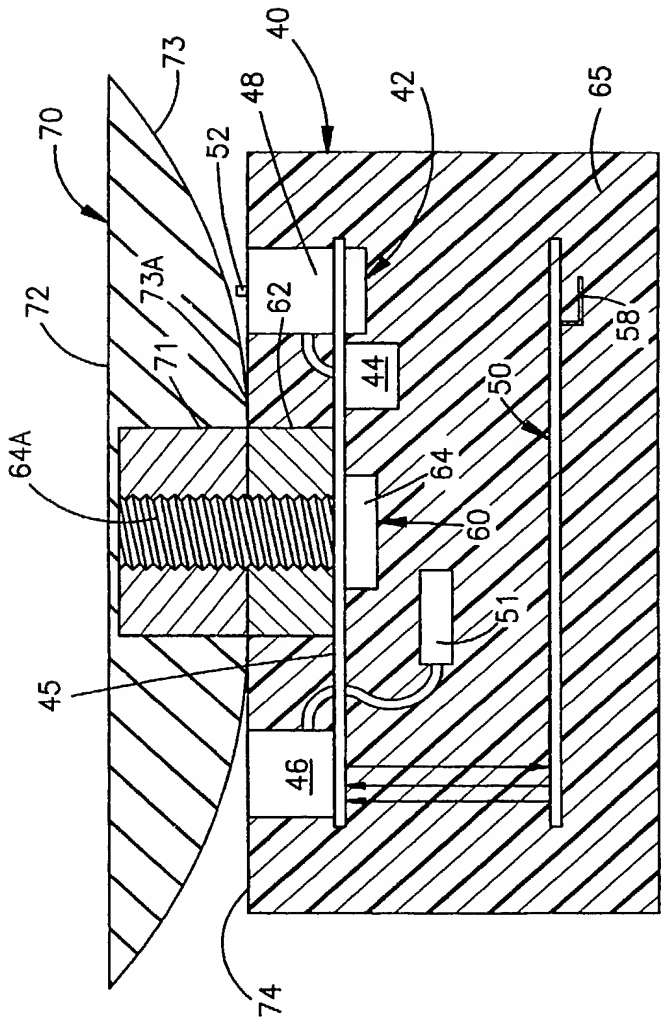

Figure 2

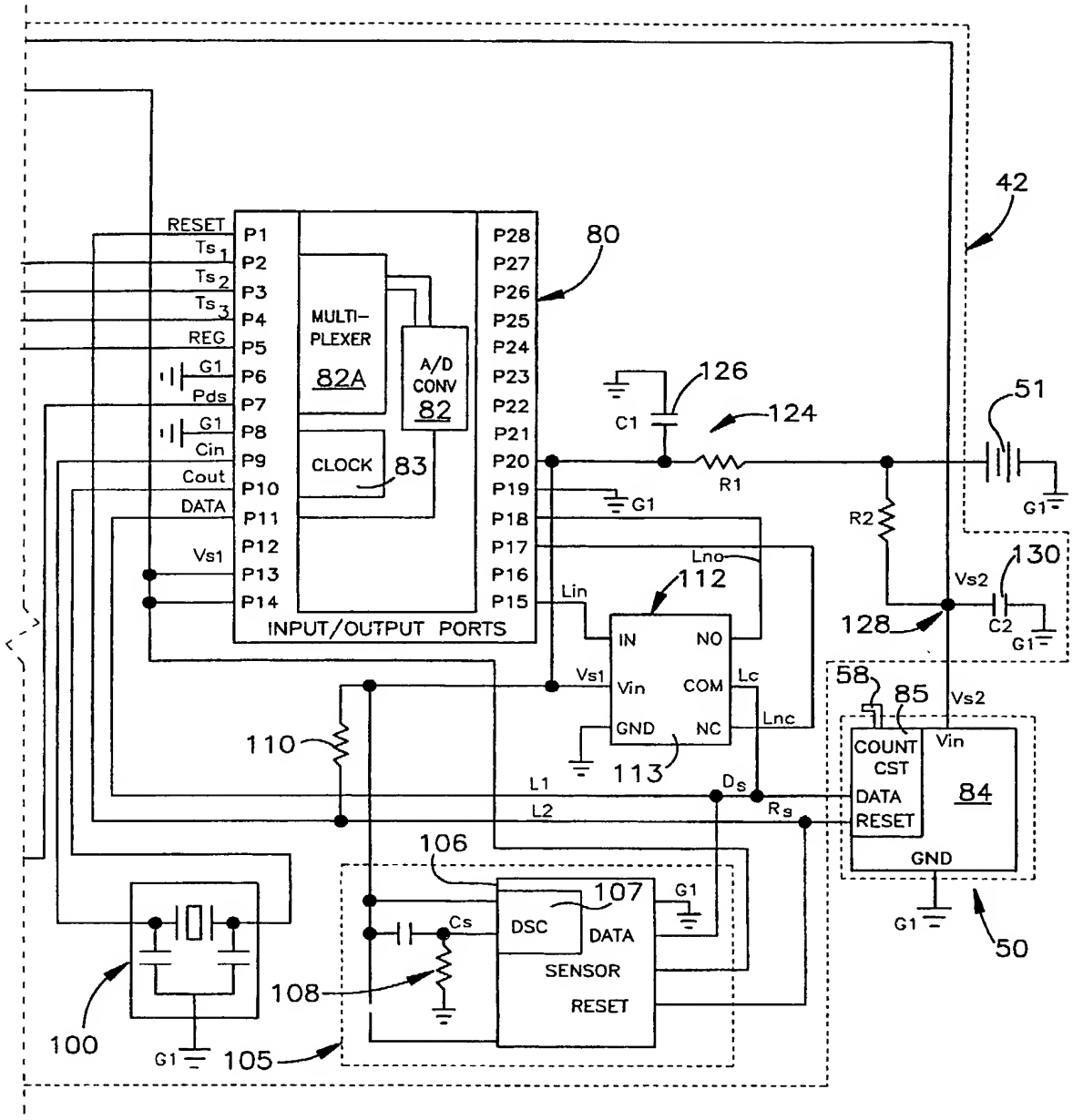

Figure 3

AMENDED SHEET

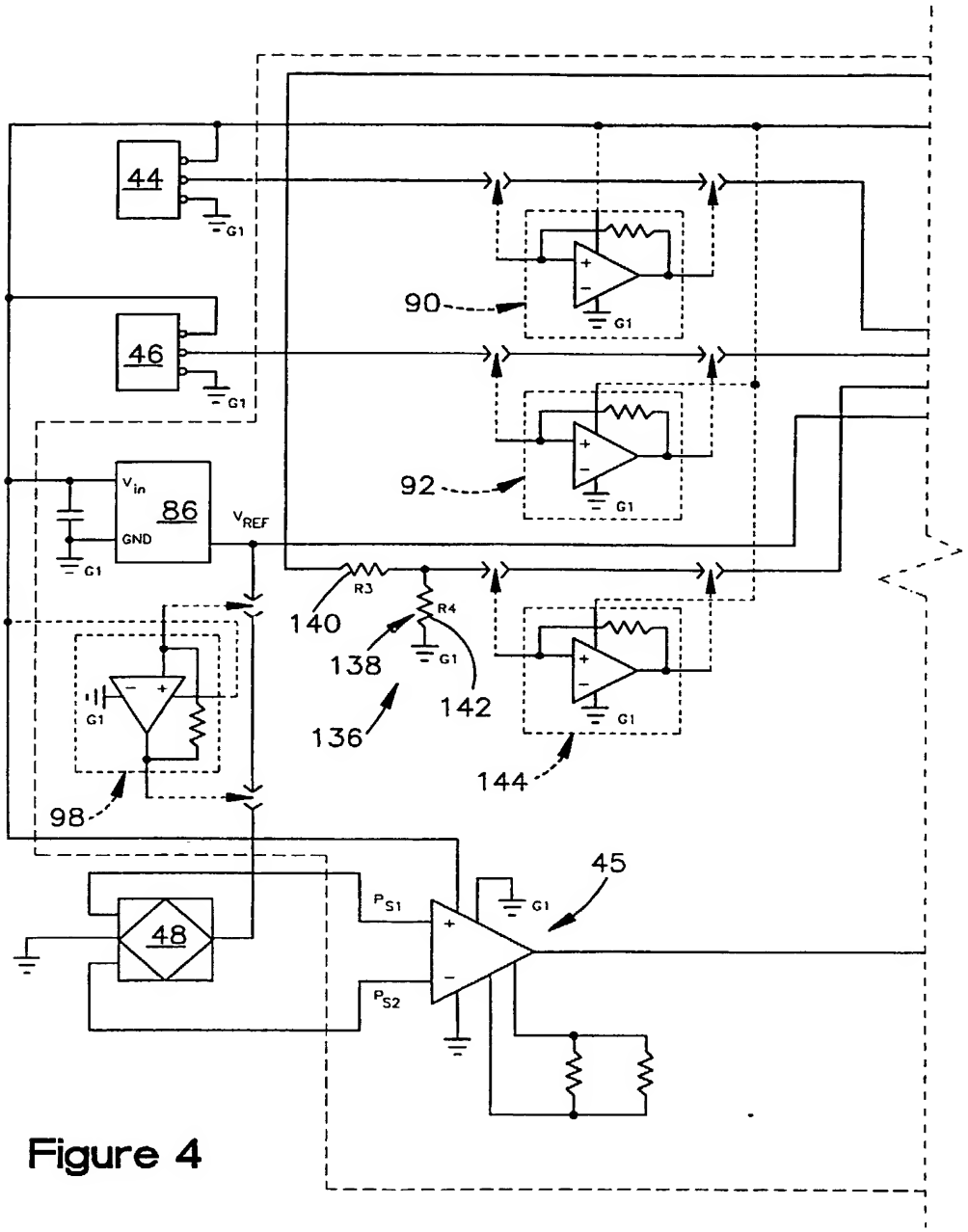
44
G1
46
G1
V_{in}
86
GND
G1
V_{REF}
90
92
G1
G1
R3
R4
140
138
136
142
G1
G1
144
98
45
48
P_{S1}
P_{S2}
G1

Figure 4

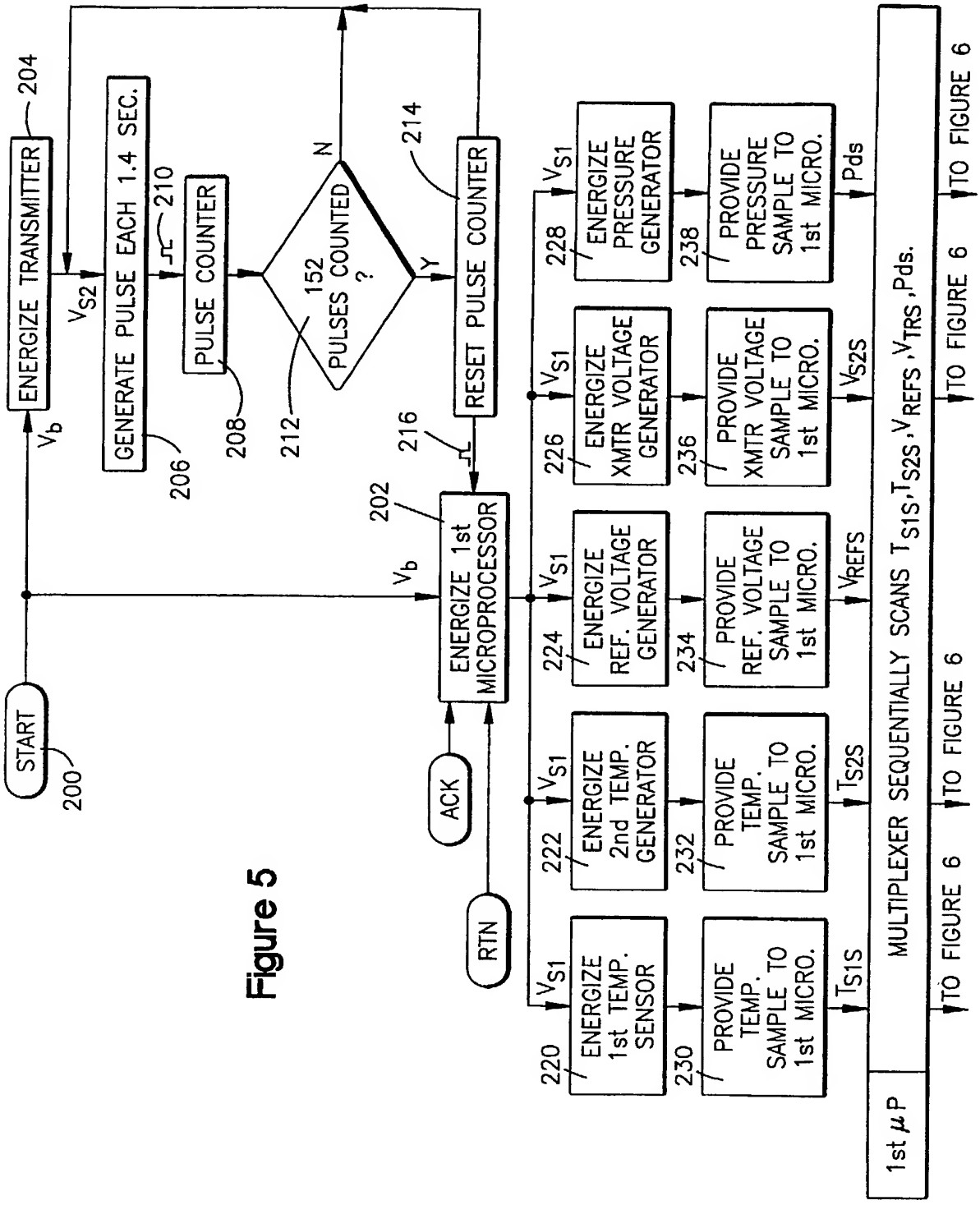
START
200
ENERGIZE TRANSMITTER
204
GENERATE PULSE EACH 1.4 SEC.
206
PULSE COUNTER
208
PULSES COUNTED ?
152
212
N
Y
210
214
RESET PULSE COUNTER
216
ENERGIZE 1st MICROPROCESSOR
202
ACK
RTN
V_b
V_{S2}
V_{S1}
ENERGIZE 1st TEMP. SENSOR
220
ENERGIZE 2nd TEMP. GENERATOR
222
ENERGIZE REF. VOLTAGE GENERATOR
224
ENERGIZE XMTR VOLTAGE GENERATOR
226
ENERGIZE PRESSURE GENERATOR
228
PROVIDE TEMP. SAMPLE TO 1st MICRO.
230
PROVIDE TEMP. SAMPLE TO 1st MICRO.
232
PROVIDE REF. VOLTAGE SAMPLE TO 1st MICRO.
234
PROVIDE XMTR VOLTAGE SAMPLE TO 1st MICRO.
236
PROVIDE PRESSURE SAMPLE TO 1st MICRO.
238
T_{S1S}
T_{S2S}
V_{REFS}
V_{TRS}
Pds
1st μP
MULTIPLEXER SEQUENTIALLY SCANS T_{S1S}, T_{S2S}, V_{REFS}, V_{TRS}, Pds.
TO FIGURE 6
TO FIGURE 6
TO FIGURE 6
TO FIGURE 6

Figure 5

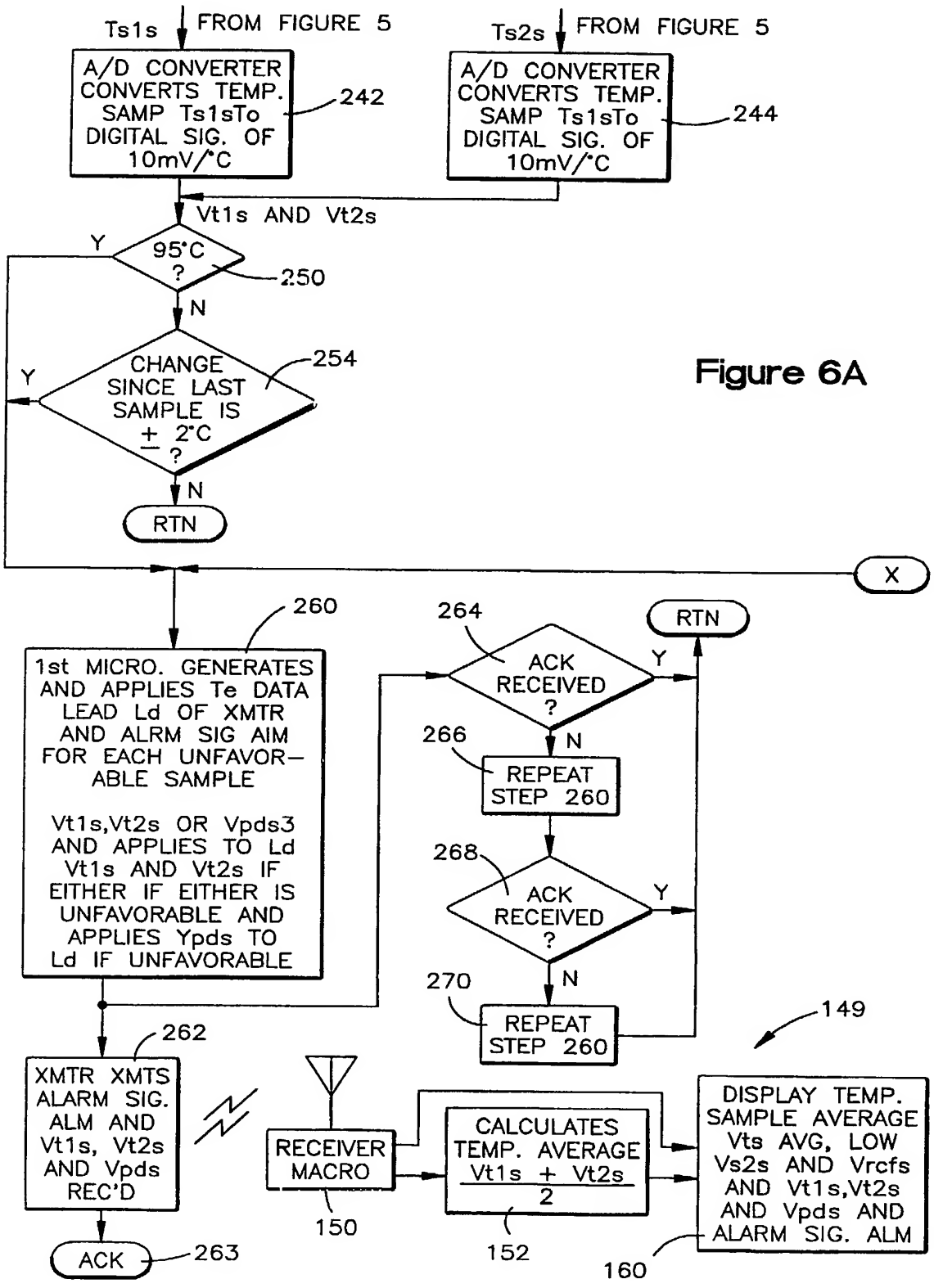
Ts1s FROM FIGURE 5
Ts2s FROM FIGURE 5
A/D CONVERTER CONVERTS TEMP. SAMP Ts1sTo DIGITAL SIG. OF 10mV/°C
242
A/D CONVERTER CONVERTS TEMP. SAMP Ts1sTo DIGITAL SIG. OF 10mV/°C
244
Vt1s AND Vt2s
95°C ?
250
Y
N
CHANGE SINCE LAST SAMPLE IS ± 2°C ?
254
Y
N
RTN
X
260
1st MICRO. GENERATES AND APPLIES Te DATA LEAD Ld OF XMTR AND ALRM SIG AIM FOR EACH UNFAVOR-ABLE SAMPLE
Vt1s,Vt2s OR Vpds3 AND APPLIES TO Ld Vt1s AND Vt2s IF EITHER IF EITHER IS UNFAVORABLE AND APPLIES Ypds TO Ld IF UNFAVORABLE
262
XMTR XMTS ALARM SIG. ALM AND Vt1s, Vt2s AND Vpds REC'D
ACK
263
264
ACK RECEIVED ?
Y
N
RTN
266
REPEAT STEP 260
268
ACK RECEIVED ?
Y
N
270
REPEAT STEP 260
149
RECEIVER MACRO
150
CALCULATES TEMP. AVERAGE Vt1s + Vt2s / 2
152
DISPLAY TEMP. SAMPLE AVERAGE Vts AVG, LOW Vs2s AND Vrcfs AND Vt1s,Vt2s AND Vpds AND ALARM SIG. ALM
160

Figure 6A

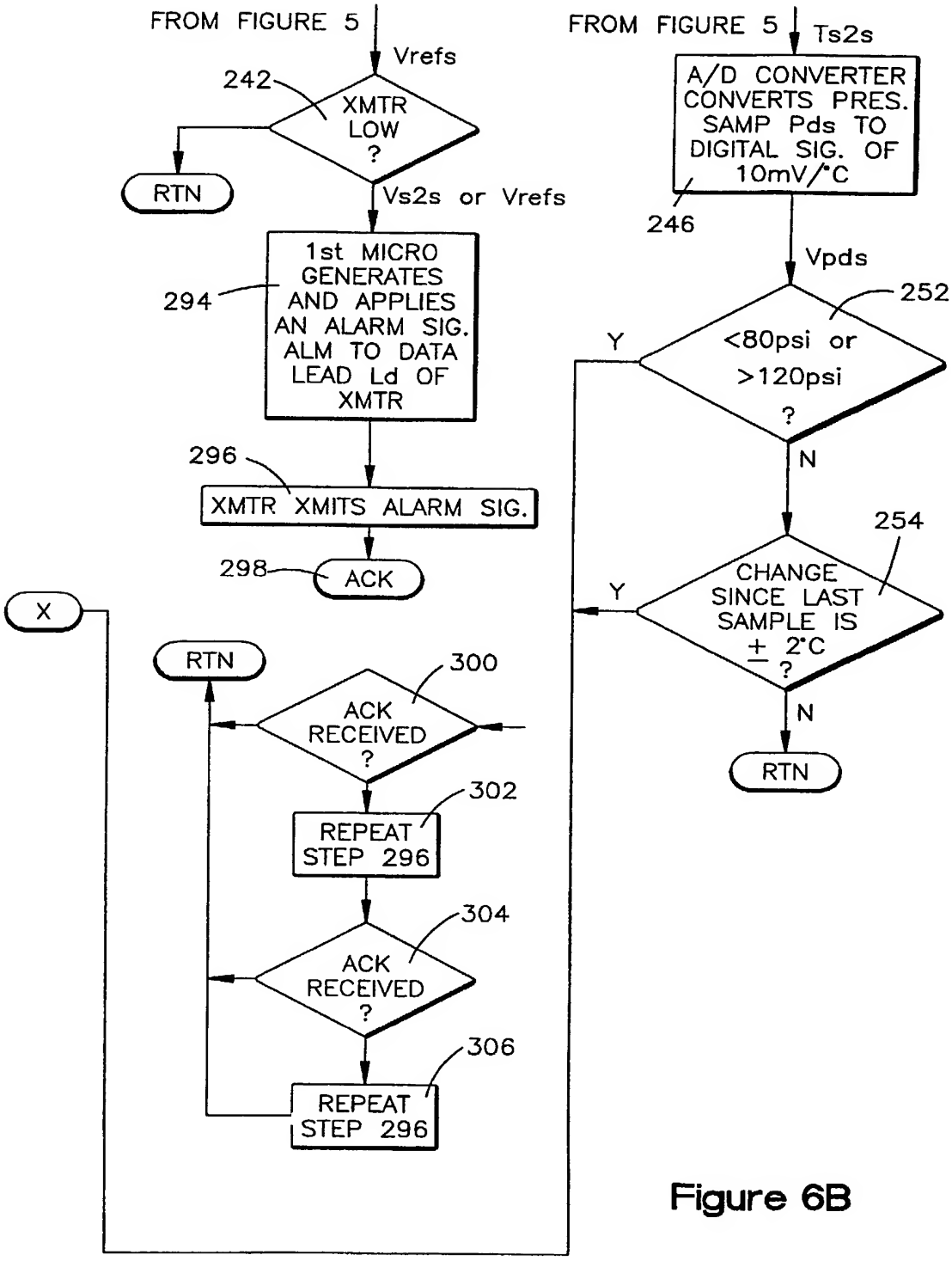

Figure 6B

AMENDED SHEET

1.0089135 .032502

Docket No. DN1999219

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled APPARATUS FOR MONITORING A CONDITION OF A TIRE the specification of which (check one)

_____ is attached hereto.

X was filed on October 1, 1999 as Application Serial No. PCT/US99/22882 and was amended on October 5, 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. §1.56.

I hereby claim the benefit under 35 U.S.C. §119(c) of any United States provisional application(s) listed below:

(Application Serial No) (Filing Date)

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or §365 of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. §1.56 which become available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No) (Filing Date) (Status)(patented, pending, abandoned)

POWER OF ATTORNEY

As named inventor(s), I or we hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

3

David L. King	Registration No.	33,925
Howard M. Cohn	Registration No.	25,808
Nancy T. Krawczyk	Registration No.	38,744

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statement may jeopardize the validity of the application or any patent issuing thereon.

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